CLAIMS

1) Equipment for preparing for electrostatic painting three-dimensional articles (P) with a predominantly flat extension, made from dielectric or low-conductivity material, which move on and are supported by a horizontal conveyor (T), characterized in that the conveyor is made from an electrically insulating material, having a resistivity greater than that of the panels (P) to be painted and characterized in that one or more electrodes (E, 12) are placed in isolated positions, at suitable distances from each other and from the edges of the panels, under the said panels, at least while the powdered paints electrostatically charged to an electrical potential are being fed on to them, the electrodes emitting an electrical field with characteristics such that it charges the whole visible surface of the said panels, as far as their area of contact with the conveyor, to an electrical potential of opposite sign to that of the powdered paints, in such a way that the powdered paints completely and uniformly cover the said visible surface of the panels.

2) Equipment according to Claim 1, in which the conveyor (T) is made from a sufficiently porous material, permeable to air but not to the paint powders.

3) Equipment according to Claim 2, characterized in that the lower return run of the conveyor (T) is cleaned not only by conventional methods but also with a jet of pressurized air which passes through the said return run from the interior to the exterior, suction means being provided opposite these means to collect and remove the dust resulting from this cleaning operation.

4) Equipment according to Claim 1, in which the conveyor (T) is made, at least in the part in contact with the panels (P) to be painted, from a material whose resistivity is greater by at least one order of magnitude than that of the said panels.

5) Equipment according to Claim 4, in which the conveyor (T) is made wholly or partially from polyethylene.

6) Equipment according to Claim 1, in which the electrode (E) for polarizing the panel to be painted is located at a distance from the edge of the said panel which is greater than 0.5 to 4 times, and preferably greater than 1 to 2 times, the height (H) of

the edge of the said panel (P).

7) Equipment according to Claim 1, in which the electrode (E) for polarizing the panel to be painted is located at a distance from the edge of the said panel which is not more than 5 to 20 times, and preferably not more than approximately 10 times, the height (H) of the edge of the said panel (P).

8) Equipment according to Claim 1, in which, when the shape of the panels (P) is such that they have to be acted on by a plurality of electrodes (E), the distance between the said electrodes is not less than 5 to 20 times, and preferably not less than approximately 10 times, the height H of the edge of the said panel (P).

9) Equipment according to Claim 1, in which the electrodes (E) are of any suitable shape for their intended purpose, are fixed with a precise distribution to the conveyor (T) so that they are as close as possible to or directly in contact with the panel to be painted, and are connected, by means of extensions or by means of electrical conductors (N) connected to them, to corresponding fixed contacts (Q) connected to the lower face and/or to the edges of the conveyor, where the said contacts are distributed in rows for interaction with the power supply collectors (Y) which are supplied selectively, according to the dimensions of the panels to be painted, by at least one switching unit (K) connected to the electrical generator (X).

10) Equipment according to Claim 9, in which the collectors (Y) and the switching and power supply units (K, X) are fixed.

11) Equipment according to Claim 9, in which the collectors (Y) are movable with forward and return reciprocating movements in the direction of the movement of the panels to be painted.

12) Equipment according to Claim 1, in which the electrodes (E) are of any suitable shape for their intended purpose and are positioned under the upper run of the conveyor (T) for advancing the panels to be painted, the thickness of the conveyor being reduced in order to cause the least possible attenuation of the electrical field generated by the said electrodes which are located at least near the painting unit or units (R) and can be connected selectively to the electrical generator (X) through at least one switching unit (K), in such a way that they can be activated

selectively, at least in accordance with the dimensions in plan view of the panels to be painted.

13) Equipment according to Claim 12, in which the electrodes (E) are mounted on motorized sliders (S) by means of which their position can be adjusted in space, for better adaptation to the dimensions in plan view of the panels to be painted.

14) Equipment according to Claim 12, in which the electrodes (E) are fixed.

15) Equipment according to Claim 12, in which the electrodes (E) are mounted on structures by means of which the said electrodes can be given a cyclical forward and return movement in the direction of the movement of the panels to be painted.

16) Equipment according to Claim 15, in which the said means of movement are means (S) of reciprocating rectilinear movement.

17) Equipment according to Claim 15, in which the said means of movement are means (M) of continuous movement of the closed conveyor type and the electrodes are connected to the switching and power supply source (K, X) by means of collectors (Y) of the sliding contact or other suitable type.

18) Equipment according to Claim 12, in which means are provided for controlling the operation of the electrodes in accordance with the dimensions and the positioning in space of the panels to be painted and these means comprise a switching unit (K) connected to the electrical polarization generator (X) and controlled by a processor (L) which receives the information on the dimensions of the panels from optoelectronic means (B) located up-line from the paint chamber (C) and which receives from an encoder (G) the information on the speed of advance of the conveyor (T), means being provided to enable the said processor to operate with access to the information on the position in space at any moment of the panel to be painted.

19) Equipment according to Claim 1, characterized in that the belt conveyor (T) for advancing the articles to be painted has a thickness which is restricted as much as possible and is in the range from 0.5 to 3 mm, for example approximately 0.8 mm.

20) Equipment according to Claim 19, in which the belt conveyor (T) is formed from a polyester fabric core or equivalent material, impregnated with polyurethane or

equivalent material, and is coated at least on its upper face with polyurethane or equivalent material, in such a way that it has a perfectly smooth outer surface which is particularly suitable for cleaning with mechanical and pneumatic means which operate according to the prior art on the return run of the belt conveyor.

21) Equipment according to Claim 20, in which the polyurethane layer is approximately 0.2 mm thick.

22) Equipment according to Claim 19, in which the upper run of the conveyor belt (T) slides on and is supported by a flat horizontal bed (7) supported by the frame of the machine and made, for example, from polypropylene and/or any electrically insulating material, which has a resistivity greater than that of MDF and which is coated on the face in contact with the said conveyor belt (T) with at least one sheet (8) of the same material as that of the belt (T).

23) Equipment according to Claim 19, in which the electrodes (12) are mounted at equal distances from each other and in such a way that they can be activated and de-activated, on one or more rectilinear closed conveyors (9) of the horizontal axis type, which are made from electrically insulating material, are positioned longitudinally under the upper run of the said belt conveyor (T), move in the same direction and at the same speed as this conveyor (T), and have a length such that they follow the panels positioned above them throughout the painting cycle.

24) Equipment according to Claim 23, in which the conveyor (9) of the electrodes takes its motion from the transmission system (3) which also drives the belt conveyor (T) of the painting machine.

25) Equipment according to Claim 22, in which the bed (7, 8) supporting the upper run of the conveyor (T) has at least one longitudinal aperture (107) which leaves free the portion of the said conveyor on which the electrodes (12) for polarizing the articles to be painted (P) can act by contact.

26) Equipment according to Claim 22, in which the conveyor (9) which carries the electrodes is formed from a chain of links (109) of electrically insulating material, which carry at constant intervals projecting appendages (209), also made from electrically insulating material, on which are pivoted by their forked ends metal levers

(112) each of which carries integrally and transversely on its other end a metal head (12) which forms the actual electrode for polarizing the panels, the said lever (112) being pivoted on the said supporting appendage (209) by means of a freely rotatably metal pin (13) which has at one end a small lever (113) which terminates in a rounded end and which is constantly orientated downwards by gravity or by the action of suitable means and which while travelling along the upper run of the conveyor in question slides on a linear metal collector (20) connected to the voltage generator (X) for the necessary polarization of the electrodes.

27) Equipment according to Claim 23, in which the electrodes attached to the conveyor (9) are spaced apart from each other at decimal intervals, for example 10 to 20 cm.

28) Equipment according to Claim 26, in which the metal head (12) of the said oscillating metal lever (112), which forms the actual electrode, is for example formed from a length of tubular section with a rectangular cross section, orientated in such a way that, as it travels along the upper run of the conveyor (9), if the electrode is to be in the high active position, the said head (12) uniformly touches the lower face of the belt conveyor (T) with one of its larger faces.

29) Equipment according to Claim 26, in which the electrode (12) has approximately the following dimensions: 20 x 10 x 65 mm.

30) Equipment according to Claim 26, in which there is provided, under the lower run of the electrode conveyor (9) and parallel to it, a fixed guide (14), made from electrically insulating material at least in its upper part and having a curved initial portion (114) for collecting the electrodes leaving the upper run of the corresponding conveyor, this guide having the function of preventing the said electrodes from oscillating in an unnecessary and dangerous way along the return path, and positioning the said electrodes correctly for interaction with a metal brush (15) connected to earth for eliminating any residual voltage on the electrodes before their return to the upper run of the conveyor (9).

31) Equipment according to Claim 26, in which each of the electrodes (12) carries on at least one end an integral skid (212) made from electrically insulating material

and with a low coefficient of friction, which, during the movement of the electrodes, interacts with guide means which place the said electrodes correctly in the active or passive position in which they contact or do not contact the upper run of the belt conveyor (T) of the painting machine.

32) Equipment according to Claim 26, in which a fixed cam in the form of a sector of a circle (16), preferably made from electrically insulating material, is provided coaxially with the return shaft (10') of the electrode conveyor (9), this cam interacting with the end skids (212) of the said electrodes (12) which, as a result of this interaction, are kept away from the links (109) of the chain of the said conveyor, to ensure that these links have a freedom of relative movement on the curved path around the said shaft.

33) Equipment according to Claim 26, in which an inclined plane cam (17) is provided in the initial part of the upper run of the electrode conveyor (9), this cam being transferable by an actuator (18) from a high position to a low position at the command of the processor which controls the operation of the machine and which, additionally acting on the basis of the data received from an optoelectronic barrier (B) or other means which detects the dimensions of the panels (P) on entry into the painting machine and on the basis of data received from a sensor (118) which detects the phase of the electrodes (12), decides whether the said electrodes cyclically reaching the upper position are to be activated or not, and therefore whether the said inclined plane cam is to be in the high or low position respectively.

34) Equipment according to Claim 33, in which the initial part, suitably tapered to form a lead-in, of a linear guide (19), preferably made from electrically insulating material, is provided down-line from the movable inclined plane cam (17) when the latter is in the high position, the guide being fixed to the frame of the conveyor in question, parallel to the said conveyor, the end skids (212) of the electrodes (12) rising on to and sliding along the guide and thus being raised and kept in contact with the conveyor belt (T), another fixed guide (19'), also made from electrically insulating material and with a low coefficient of friction, being provided opposite the said guide (19) and parallel thereto, the other ends of the electrodes (12) sliding and bearing

directly, or with the interposition of an additional skid, on the guide (19'), and thus advancing with a uniformly distributed and constant contact with the conveyor (T) above them.

35) Equipment according to Claim 33, in which, if the said wedge-shaped guide (17) is in the low position, the electrodes (12) advance in the low position, each in contact with a link of the corresponding conveyor (9), in a position suitably distant from the conveyor (T) of the painting machine.

36) Equipment according to Claim 26, in which the pivot pins (13) of the levers (112) carrying the electrodes (12) and carrying at their ends the levers (113) for making contact with the linear collector (20) for polarizing the electrodes, are axially movable and each is provided, at the opposite end from the lever (113), with a head (213), and means are provided for changing the position in space of these pins, to ensure that only the lever (13) of each electrode which is to be in the high active position touches the said collector (20), while the lever of each electrode in the low and inactive position follows a path to one side of and distant from the said collector, so that the corresponding electrodes are not polarized.

37) Equipment according to Claim 36, characterized in that, before leaving the lower run of the electrode conveyor (9), the end lever (113) of each pivot pin (13) of the said electrodes which has previously left a stage of interaction with the upper collector (20) interacts with a linear fixed cam (21) made from electrically insulating material, which forces the said pin to move axially so that the lever (113) is brought closer to the supporting appendage (209), in such a way that all the levers (113) which are leaving the lower run of the electrode conveyor (9) and which are about to rise to the upper run are positioned on the links (109) of this conveyor and consequently to one side of and distant from the position in space occupied by the said polarization collector (20).

38) Equipment according to Claim 37, characterized in that there is provided, in the initial part of the upper run of the electrode conveyor (9), an exchange device (22) which, at the command of the processor, moves axially the pivot pins (13) of only those electrodes (12) which are to remain in the high active position, in such a

way that the levers (113) of these pins move along a trajectory of interaction with the linear polarization collector (20).

39) Equipment according to Claim 38, in which the exchange device (22) comprises a right-angled lever (122) pivoted on a vertical axis (222) and connected to an oscillation actuator (322) which, when commanded, can move the said lever from the resting position, in which it does not interfere with the pivot pins (13) of the electrodes, to the active position in which one arm of this lever is inclined so that it interferes with the heads (213) of the said pins (13), to subject them to the axial movement which causes the corresponding lever (113) to interact with the linear polarization collector (20) of the electrodes.

40) Equipment according to Claim 19, in which the electrodes (E) for polarizing the panels to be painted are fixed on the bed (7) which supports the upper run of the conveyor (T) for advancing the said panels and are positioned at isolated points located one after the other in at least one row whose length is suitably greater than the length of the paint chamber (C) and which is orientated along the longitudinal axis of this chamber.

41) Equipment according to Claim 40, in which the row of electrodes (E) can be positioned with a slight inclination in the range from 0° to 15°, for example approximately 7°, with respect to the longitudinal axis of the conveyor (T), in such a way that the said electrodes are arranged progressively in different positions with respect to the edges of the panels, to ensure that the panels are correctly and uniformly covered with paint.

42) Equipment according to Claim 40, in which the electrodes (E) can be positioned in different ways on the vertices of a broken line which forms a wave of the alternating type, with the horizontal axes suitably inclined with respect to the longitudinal axis of the conveyor (T), in such a way that the said electrodes are also widely distributed over the width of the said conveyor (T) for advancing the articles to be painted.

43) Equipment according to Claim 40, in which the electrodes (E) are suitably spaced apart from each other, for example by distances of approximately 5 to 20

times, for example approximately 10 times, the height of the edges of the panels to be painted.

44) Equipment according to Claim 40, in which the electrodes (E) can be made in the form of screws with flat countersunk heads, with hexagonal sockets, and with shanks of suitable diameter, for example in the range from 5 to 15 mm.

45) Equipment according to Claim 44, in which the screws forming the electrodes (E) are fixed in holes formed in the bed (7) above which the upper run of the conveyor (T) slides, in such a way that the flat faces of their heads are coplanar with the upper face of the said bed (7).

46) Equipment according to Claim 44, in which the screws forming the electrodes (E) are fixed in holes formed in the bed (7) and in the corresponding upper cover (8) above which the upper run of the conveyor (T) slides, in such a way that the flat faces of their heads are essentially in contact with the said conveyor (T) for advancing the panels.

47) Equipment according to Claim 40, in which means are provided for ensuring that the electrodes (E) of each row are all constantly connected to the polarization generator.

48) Equipment according to Claim 40, characterized in that means are provided for modulating the activation and inactivation of the electrodes (E) of each row in accordance with the variations of the positions above them of the panel to be painted, which moves continuously, in such a way that the said electrodes, in the active phase, are never active at critical distances or too close to the edges of the panels.

49) Equipment according to Claim 48, in which the electrodes (E) can be connected to the polarization source (X) through a switching unit (K) controlled by a processor unit (L) which receives from the barrier (B) and from an encoder (G) the data relating to the dimensions and speed and consequently to the position in space of the panels to be painted.

50) Equipment according to Claim 49, in which the switching unit (K) comprises switches of the static electronic type.

51) Equipment according to Claim 49, in which the switching unit (K) comprises switches of the dynamic type, consisting for example of small cylinder and piston units (27), located under the screws forming the electrodes (E), having their rods aligned and orientated against these screws and holding, with the interposition of an insulating support, an electrical contact (28) connected to the polarization unit (X).

52) Equipment according to Claim 40, in which the terminal part (T') of the conveyor (T) has a downward inclination and continues to be supported by the bed (7, 8), while there is provided above this final inclined portion (101) a wedge-shaped conveyor (29) of suitable material, whose upper run is coplanar with and immediately consecutive to the horizontal run of the said conveyor (T) and advances in such a direction and at such a speed that it collects and removes the painted panel.

53) Equipment according to Claim 52, in which means are provided to clean the paint from the said wedge-shaped conveyor (29).

54) Equipment according to Claim 1, in which the polarization generator (X) of the electrodes (12) can generate a continuous voltage which can vary from 0 to 100 kV, with a useful value, for example, in the region of 60 kV, and with a current measurable in microamperes, for example approximately 500 A.

55) Equipment according to Claim 19, characterized in that, since the conveyor belt (T) is very thin and thus relatively elastic, and consequently sensitive to the resistances which it encounters during its advance, which are not balanced and symmetrically distributed, and therefore the said conveyor tends to slip sideways, automatic means are provided to keep it correctly centred and guided on the corresponding return rollers (2, 2').

56) Equipment according to Claim 55, characterized in that the driven end of the conveyor belt (T) of the painting machine runs over a pair of parallel static rollers, one above the other (2'), supported rotatably by the fixed frame (1) of the machine, and over a third roller (102) which forces the conveyor belt to form a re-entrant bend and which is located between the aforesaid rollers (2') or after the lower roller and is parallel to these, but is mounted rotatably at each end on the intermediate part of a corresponding lever (23) one end of which is pivoted on the said fixed frame (1) and

the other end of which is connected to an oscillation actuator (25), of the pneumatic type for example, connected to an operating circuit with the interposition of a unit (26) having a feeler (126) which senses the position in space of the side of the conveyor (T) adjacent to the said lever (23), the whole system being designed in such a way that if the conveyor moves outwards and causes the said feeler (126) to be bent outwards, the unit (26) switches and causes the temporary retraction of the rod of the actuator (25) through a predetermined distance which returns the conveyor (T) to its track, causing a reduction of the force on the feeler (126) and the switching back of the unit (26) which returns the actuator (25) to the resting position.

57) Equipment according to Claim 23, characterized in that, if the belt conveyor (T) of the painting machine has a width such that it can accommodate panels which may be of considerable width, where movable electrodes are used, a plurality of conveyors (9) with corresponding electrodes (12) can be positioned side by side and in a parallel arrangement under the upper run of the said conveyor, with a distance between the electrodes of one conveyor and those of the neighbouring conveyor which is not less than that between the electrodes of each conveyor, and/or with the electrodes of one conveyor staggered if necessary with respect to those of the adjacent conveyor, and means are provided for selectively activating these conveyors (9) and/or the corresponding movable electrodes (12) in accordance with the dimensions of the panels to be painted.

58) Equipment according to Claim 40, characterized in that, if the belt conveyor (T) of the painting machine has a width such that it can accommodate panels which may be of considerable width, where fixed electrodes are used, a plurality of rows of electrodes (E) can be positioned side by side, with a distance between the electrodes of one row and those of the neighbouring row not less than that between the electrodes of each row, and/or with the electrodes of one row staggered if necessary with respect to those of the adjacent row, and means are provided for selectively activating the rows of fixed electrodes (E) in accordance with the dimensions of the panels to be painted.